PROGRAM COMMENT FOR DEPARTMENT OF DEFENSE
REHABILITATION TREATMENT MEASURES

APPENDIX 2

SECTION 04100.02 PREPARATION OF LIME AND CEMENT-AMENDED MORTARS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This specification provides procedures appropriate for preparing lime and cement-amended mortars for use in repointing historic masonry.

B. This specification has been developed for use on historic properties (defined as any district, site, building, structure, or object that is listed in or is eligible for listing in the National Register of Historic Places) and provides an overview of accepted practices.

C. All work described herein and related work must conform to the Secretary of the Interior's Standards for the Treatment of Historic Properties.

D. The Contractor shall provide all labor, materials, equipment, and operations required to complete the rehabilitation work indicated herein.

E. All work described herein and related work must have the approval of a Cultural Resources Manager, Conservator, Historic Architect, or other professional who meets the standards outlined in the Secretary of the Interior's Standards – Professional Qualifications Standards pursuant to 36 CFR 61. Such person is referred to in this document as the ***Architect***.

F. Site-specific specifications, when appropriate, will be provided by the Architect.

1.02 SECTION INCLUDES

A. Mortar selection

B. Preparation of lime mortar

C. Preparation of cement-amended mortar

1.03 RELATED SECTIONS

A. Section 04100.01 – Removal of Mortar Joints and Repointing

B. Section 04211 – Historic Brick (pending issuance)

C. Section 04214 – Terra Cotta and Ceramics (pending issuance)

D. Section 04400.01 – Identifying Masonry Types and Failures

E. Section 04500 – Masonry Restoration (pending issuance)

1.04 REFERENCES

A. *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings*, available at the National Park Service (NPS) website at <http://www.nps.gov/history/hps/tps/standards_guidelines.htm>.

B. Use and types of mortar are found in *Preservation Brief No. 2: Repointing Masonry Joints in Historic Masonry Building*, available online at the NPS website at <http://www.nps.gov/history/hps/tps/briefs/brief02.htm>.

C. U.S. General Services Administration Historic Preservation Technical Procedures for Mortar, available online at http://w3.gsa.gov/web/p/hptp.nsf/a533f1f859737bc9852565cc0058d0b6/7de342045d4c63f6852565c50054b3a7?OpenDocument> and <http://w3.gsa.gov/web/p/hptp.nsf/a533f1f859737bc9852565cc0058d0b6/e7518da3d776f026852565c50054b3c5?OpenDocument>.

D. Weaver, Martin E. *Conserving Buildings: A Manual of Techniques and Materials*. Revised edition. New York: John Wiley & Sons and the Preservation Press, 1997.

E. ASTM C207, *Standard Specification for Hydrated Lime for Masonry Purposes*

F. ASTM C206, *Standard Specification for Finishing Hydrated Lime*

G. ASTM C144, *Standard Specification for Aggregate for Masonry Mortar*.

H. ASTM C150, Type II, *Standard Specification for Portland Cement.*

I. ASTM C979, *Specification for Pigments for Integrally Pigmented Concrete.*

J. ASTM C170 – Compressive Strength of Natural Building Stone

K. ASTM C5 Standard Specification for Quicklime for Structural Purposes

1.05 SUBMITTALS

A. The Contractor shall submit a detailed schedule of the areas to be repointed, including an assessment of the problem areas, a historic mortar analysis, and a detailed procedure for repointing, to the Architect for approval:

1. Submit data indicating proportion or property specifications used for mortar.

2. Submit test reports for mortar materials and report proportions resulting from laboratory testing used to select mortar mix.

B. Product Literature: The Contractor shall submit the manufacturer's product literature to the Architect for all proprietary products specified for repointing. Product literature shall include specification data, Material Safety Data Sheets, and instructions for storage, handling, and use.

C. Historic Mortar Analysis: The Contractor shall submit the laboratory report from completed mortar analysis. Mortar analysis shall be completed prior to beginning test-panel preparation. At a minimum, analysis shall be a wet chemical and microscopic

analysis to characterize the insoluble aggregate, determine binder-aggregate ratio, prepare a mix design for replacement mortar, and identify appropriate sources for sand aggregate. If circumstances so dictate it, the Architect shall require the contractor to submit alternate mortar analyses, such as X-ray diffraction.

D. Samples: No masonry restoration work shall proceed until all samples are approved by the Architect. The Contractor shall submit samples of the following masonry repair and replacement materials for approval of color and texture match:

Cured pointing mortar. Portable samples shall be prepared using drywall channel or similar material the approximate width of a mortar joint. Once a matching mortar color is achieved, placement of on-site mock-ups may begin.

1.06 QUALITY ASSURANCE

A. Work Experience: The Contractor and Masons to perform the work in this section shall have demonstrated experience approved by the Architect, ideally a minimum of ten (10) years experience with historic mortars and masonry repairs and repointing. He/she shall demonstrate a working knowledge of the Secretary of the Interior's Standards for Guidelines for Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing Historic Buildings.

B. The Contractor shall not change sources or manufacturers of mortar materials during the course of the work.

1.07 MOCK-UPS

A. The Contractor shall prepare two mock-up installations of each type of mortar color for each type of masonry to be installed at locations selected by the Architect. If cleaning tests are also to take place, test panels should be in the same area. Test panels should not be undertaken in areas that are highly visible.

B. Each test panel shall be executed in the same manner as the final installation. Test panels shall be a minimum area of 3x3 feet for brick facades, and larger for stone facades.

C. After the test panels have cured for a period of two to three weeks (or otherwise specified by the Architect), the test panels will be inspected for color, texture, and installation technique.

D. If the Architect finds the first two mock-ups unacceptable, the Contractor shall prepare up to three additional mock-ups of each mortar and mortar color without further compensation. Test area(s) approved by the Architect shall become part of the work and shall serve as the quality standard for all subsequent work.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall deliver all products to the site in original packaging, unopened and undamaged, with manufacturer's name and product identification visible thereon and manufacturer's instructions and Material Safety Data Sheets.

B. The Contractor shall store products in a dry location and protect them from dampness and freezing following manufacturer's instructions.

C. The Contractor shall stockpile and handle aggregates in a manner to prevent contamination from foreign materials.

1.09 PROJECT / SITE CONDITIONS

A. Mortar installation shall executed only when the air and surface temperatures are 40 degrees F and rising or less than 80 degrees F and falling. Minimum temperature for masonry repointing shall be 50 degrees F and above for at least 2 hours after completion and above freezing for at least 24 hours after completion. Work shall not commence when rain, snow, or below-freezing temperatures are expected within the next 24 hours. All surfaces shall be free of standing water, frost, and ice.

B. The Contractor is responsible for protecting existing adjacent materials and surfaces during the execution of the work, and will provide all necessary protection and follow all necessary work procedures to avoid damage to existing material assemblies not a part of the work in the Section.

C. The Contractor shall provide visible barriers and / or warning tape around the perimeter of the work area for visitor protection, and shall also provide that nearby vehicles and adjacent structures and foliage are protected from damage during the course of the work.

D. Contractor shall coordinate masonry repointing with the other trades involved in exterior and interior rehabilitation work, including but not limited to masonry cleaning, sealing, and painting.

PART 2 - PRODUCTS

2.01 MORTAR SELECTION CRITERIA: See Sections 04100.02 and 04400.01.

A. Repair mortar shall be compatible with the material, quality, color, strength and texture of the existing mortar.

B. Sand shall match the gradation of the historic mortar and be free from impurities. The color, size, and texture of the sand should be similar to the original sand.

C. Mortar shall have greater vapor permeability and be softer, measured in compressive strength, than the masonry units.

D. Mortar shall be as vapor permeable and be as soft or softer, measured in compressive strength, than the existing historic mortar.

E. Testing and Mortar Selection for Masonry Units:

1. Selection of Mortar for Brick Units:

a. Identify type and strength of brick.

b. Identify the composition, strength, and hardness of the historic mortar.

c. Lime and Sand mortars are preferred for historic brick masonry.

d. Portland cement generally should not be used for historic brick, depending on historic resource.

e. Mortar should have a lower compressive (psi) strength than brick.

2. Selection of Mortar for Terra Cotta and Ceramic Units:

a. Mortar should have a lower compressive (psi) strength than the terra cotta and ceramic units.

b. Hard, portland cements or coarsely screened mortars shall not be used, depending on the historic resource.

3. Stone:

a. Identify type of stone.

b. Identify geological and mineralogical nature of stone.

c. Identify the Compressive or Crushing Strength of stone both wet and dry: ASTM C170-87 – Compressive Strength of Natural Building Stone.

d. Mortar should have a lower compressive (psi) strength than stone: general about 1/3 the compressive or crushing strength of the stone units.

e. Hard, portland cements are generally not appropriate for historic mortars, depending on the historic resource.

4. Concrete Block and Cast Stone Units:

a. Mortar should have a lower compressive (psi) strength than the masonry units.

b. Use of concrete amended mortars, when appropriate.

2.02 MORTAR TYPE AND MIX

A. Depending on the desired strength and consistency, lime mortars should conform to ASTM C207 and ASTM C206, Mortar for Masonry, such as:

1. Type M (2,500 psi): 3:1:12

2. Type S (1,800 psi): 2:1:9

3. Type N (750 psi): 1:1:6

4. Type O (350 psi): 1:2:9

5. Type K (75 psi): 1:3:11

6. Type L: 0:1:3

OR

B. Equivalent mortar that meets comparable federal specifications.

2.03 POINTING MATERIALS AND MIXES (JOB-MIXED MORTAR)

A. Portland cement: ASTM C150, Type I, non-staining and without air entrainment. Gray and white Portland cement may be combined as required to match the desired color.

1. Non-staining white cement, preferred for historic applications, unless grey cement was used in the original mortar.

B. Hydrated Lime: ASTM C207, Type S.

C. Lime Putty (slaked lime): should conform to ASTM C5.

D. Sand: ASTM C144 Standard Specification for Aggregate for Masonry Mortar, free of clay, silt, soluble salts, and organic matter; shall match the color, size gradation, and texture of the original mortar sand. The Contractor may request from the Architect a sample of the original mortar sand, when available, for use in color and texture matching.

E. Water: Potable, free from injurious amounts of oil, soluble salts, alkali, acids, organic impurities and other deleterious substances which impair mortar strength or bonding.

F. Masonry Cement (premixed, bagged mortar): shall NOT be used.

2.04 PRE-MIXED MORTARS: Pre-mixed mortars that have been designed for use on historic buildings may be used for repointing. All such mortars must be approved by the Architect.

2.05 ACCESSORY MATERIALS

A. Historic Materials include other components that enhance the color and texture matching and may include materials such as crushed oyster shells and animal hair, and historic pigments such as brick dust and lamp black.

B. Colorants (if required for exact color match): Non-fading, mineral oxide masonry pigment as approved by the Architect.

1. Pigments should not exceed 10% by weight of the portland cement in the mix.

2. Carbon black should not exceed 2% of the Portland cement in the mix.

2.06 ADMIXTURES

A. No air-entraining admixtures or material containing air-entraining admixtures shall be added to the mortar.

B. No antifreeze compounds shall be added to mortar.

C. No admixtures containing chlorides shall be added to mortar.

2.07 EQUIPMENT FOR MORTAR PREPARATION

A. Equipment:

1. Trough, plastic buckets, hoe, wooden mallet, or similar implements

2. Mortar pan mill

3. Paddle or drum type mixers

4. Undyed, unprinted burlap

PART 3 – EXECUTION

3.01 GENERAL

A. Testing and Mortar Selection shall be approved by the Architect. The Contractor shall submit testing schedule, mortar schedule, and schedule of related repairs, including methods and materials to be used:

1. Identify masonry units: Type and composition.

2. Identify the crushing or compressive strength (psi) of masonry units.

3. Identify properties, composition, and strength of historic mortar.

4. Select mortars that match the existing in color, texture, quality, and materials.

5. Select mortars that are softer than the existing mortar and the masonry units.

B. Mortar components should be measured and mixed carefully (in a consistent manner) to assure uniformity of visual and physical characteristics.

C. Pre-mixed mortar should be mixed and handled following manufacturer's specifications.

3.02 FIELD MIXING FOR LIME MORTARS

A. Measure dry ingredients by volume.

B. In a clean trough, wheelbarrow, or mixer (depending on quantities needed) combine and mix all dry ingredients thoroughly (before adding water).

C. Add just enough clean water to "hold together," thus allowing the mixture to stand for a period prior to the addition of the remaining water.

D. Prior to use, add half of the water and mix thoroughly for five (5) minutes.

E. Add the remaining water in small portions until the desired consistency is reached. Keep the amount of water added to a minimum.

F. Mortar should be used within approximately 30 minutes of final mixing. Do not retemper or add more water after final mixing.

3.03 FIELD MIXING FOR MORTAR USING LIME PUTTY

A. Materials are measured by volume.

B. Do not add additional water.

C. Proportion sand first, and then add the lime putty.

D. Mix in a clean trough for five (5) minutes or until all the sand is thoroughly coated with the lime putty by beating with a wood mallet, interspersed by chopping with a hoe to achieve the maximum workability and performance.

OR

E. Mix in a mortar pan mill when large quantities are needed, following the sequence above. Modern paddle and drum mixers do not achieve the desired results.

F. Protect the mixture from the air by covering with wet burlap or seal in a large plastic bag.

G. The sand/lime putty mix can be stored indefinitely if placed in a sealed bag or container. Recombine mixture as specified in D above into a workable plastic state. *Do not add water*.

3.04 FIELD MIXING FOR PORTLAND CEMENT –LIME PUTTY-SAND MORTARS (Type O or Type K)

A. Materials are measured by volume.

B. Combine sand and lime putty as described above and mix. Do not add water at this point.

C. Mix the portland cement into a slurry paste using clean water.

D. Combine the portland cement slurry with the sand/lime putty mixture.

E. Add color pigments, if any.

F. Mix for five (5) minutes.

G. Mixture should be used within 30 minutes to 1 ½ hours. Do not retemper mixture. Once portland cement is added, the mortar can no longer be stored.

3.05 FINAL REPORT

The Contractor and Architect shall:

A. Document the work, testing, and mortar mixes used, and finished product, including photographs (both ‘before’ and ‘after’) and final mortar schedules.

B. Provide a written summary of the project and results upon final inspection and approval. The summary shall outline steps taken or new findings not specified in the initial documentation.

END OF SECTION